carpa] occurs west of the Cascade Mountains. The eastern Washington forms are very variable as to leaf and fruit and consist, perhaps, of two species. Specimens have frequently been referred to as *Rosa fendleri* Crépin, but it is not at all clear how this is to be distinguished." *R. Fendleri* ranges from Minnesota to British Columbia and southward to Arizona and Mexico, but it is not known to occur in Washington.

University of Washington, Seattle,
February 18, 1935.

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NOTES ON THE GERMINATION OF CEANOTHUS SEEDS

Clarence R. Quick

The writer became interested in the seed germination of native California shrubs through work on *Ribes* seed germination in the Office of Blister Rust Control, United States Department of Agriculture. The object of the experiments reported below was to determine and define a satisfactory experimental method of forcing the germination of *Ceanothus* seeds.

In 1931 seeds of *Ceanothus cordulatus* Kell. and *C. integerrimus* H. & A. were collected by the writer in the Stanislaus National Forest. Preliminary tests showed that the planting of untreated seeds of these species was futile. Martin[1] has reported that the morphological structure which caused seed coats of *Melilotus alba* Desr. to be impermeable was rapidly hydrated in

[1] Abstr. in Proc. Iowa Acad. Sci. 29: 345–346. 1922.

water at 80° C. and became permeable. Hot-water treatment held promise for *Ceanothus* seeds, but tests showed that hot water alone was not satisfactory for some species. Many kinds of seeds have an embryo dormancy which can be removed by stratification (moist storage at low temperatures).[2] The combination of a hot-water treatment with stratification in moist sand at low temperatures was indicated. Good germination of *C. cordulatus* and *C. integerrimus* was accordingly obtained after boiling seeds for five minutes and then stratifying them for three or four months at about 2.5° C. (36° F.).

Seeds. In the fall of 1933 seeds of a number of species of *Ceanothus* were obtained, and the experiment to be reported was started. A list of the seed samples used in the work is given at the end of this paper.

Methods. Five different hot-water treatments were used. (1) The seeds were counted, tied in small cheesecloth bags, weighted so that they would sink, and boiled vigorously in water for one minute. (2) The seeds were treated as in number one above, but were boiled five minutes. (3) The seeds were tied in bags as before, suspended in four liters of water at 90° C. (194° F.) contained in an enamel-ware kettle, and allowed to cool to room temperature. The seeds were then removed and planted. (4) The seeds were suspended in four liters of water at 80° C. (176° F.) contained in a small uncovered sheet-metal pail and allowed to cool to room temperature. (5) The seeds were treated in four liters of water, as in number three above, but were cooled from 70° C. (158° F.).

Two sample lots of each of the species tested were subjected to each of the five hot-water treatments. One lot was planted and placed immediately in the greenhouse. The other was planted, placed in refrigeration, watered as necessary, and, after three or three and a half months, was removed to the greenhouse for germination test. Two controls of each species, one culture stratified and another not, were tested in addition to the cultures treated with hot water.

Unless stated otherwise the seeds were planted in germination flats at a depth of about 0.6 cm. in a medium of one half river sand and one half forest loam. In most cases each culture was contained within the flat in a separate compartment made by strips of paraffined cardboard set edgewise in the flat.

Germination in the unstratified cultures was checked for

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[2] There has been a great deal of experimentation on this problem. The six articles cited below offer access to the extensive literature on the subject: Bot. Gaz. 67: 281–308. 1919; Proc. Iowa Acad. Sci. 29: 257–266. 1922; Amer. Journ. Bot. 15: 625–626. 1928; Contr. Boyce Thompson Inst. 3: 385–404. 1931; Journ. Forestry 30: 925–928. 1932; Contr. Boyce Thompson Inst. 6: 323–338. 1934.

sixteen to twenty-four weeks; in the stratified cultures for three to eight weeks after removal to the greenhouse.

The two sets of sample lots boiled for five minutes, and the two sets receiving no hot-water treatment were planted on November 23 and 24, 1933. The stratified cultures of these sets were removed from refrigeration to the greenhouse on February 16, 1934. The seeds cooled from 90° C. to room temperature were treated on January 1, 1934. The flat of stratified cultures of this treatment was placed in the greenhouse on March 30, 1934. Due to remodelling of the 2.5° C. refrigeration room, the flat had been in a 5° C. room from February 16 to March 30. This may have slowed down the changes which take place in seeds stratified at temperatures slightly above 0° C. (32° F.). The seeds cooled from 80° C. and tested immediately for germination were treated on May 5, 1934. Those cooled from 80° C. and stratified were treated on June 18, 1934, and planted, but remained in refrigeration until September 24. The seeds boiled for one minute, and those cooled from 70° C. to room temperature were treated on December 31, 1934. The stratified cultures of these two series were removed to the greenhouse on March 25, 1935.

All the flats were treated with an aqueous suspension of cupric oxalate to reduce fungous injury to seeds and to prevent the damping-off of seedlings.

Results and discussion. Table I records the percentage germination which was obtained in the various cultures. To increase readability of the table the higher germination percentages have been printed with bold-faced type. The species have been divided roughly into four habitat groups, varying from a group of species of the high forested inland mountains to those species growing in close proximity to the sea. Obviously the species within any one group are not strictly comparable as to habitat.

From the table it is apparent that a hot-water treatment is desirable in the case of most of the species. It is also apparent that stratification after hot-water treatment increases the germination percentage of many species. In other words, the seeds have coats impermeable to water, and have varying degrees of embryo dormancy as well. This embryo dormancy and need of after-ripening by stratification is marked in the high montane species, and slight or lacking in the maritime species. The other two groups are intermediate; the montane group appears to respond more to stratification than the coastal group.

With certain exceptions the boiling of *Ceanothus* seeds for five minutes appears to be too severe a hot-water treatment. In general, the 70° and the 80° treatments were the most successful in overcoming without injury the delay in germination due to seed coat hindrance. A slightly less severe treatment, for instance a 60° series, might have been more successful on some of the seed collections.

No apparent relation was found between germinative response and taxonomic relationship.

The speed of germination (rate of seedling appearance) in stratified cultures was much greater than in unstratified cultures. As an example, new seedlings were occasionally appearing in the flat of 80° unstratified cultures six months after they were placed in the greenhouse, while only one seedling appeared in the 80° stratified cultures after the second week in the greenhouse. This rapid, or simultaneous, germination is highly desirable where the seedlings are to be used in experiments, as all the seedlings are then of approximately the same age.

Barton[3] has shown that the impermeable seed coats of *Tilia americana* L. can be made permeable by four months' moist storage at 20° C. in soil or peat moss. If a similar effect on the coats of *Ceanothus* seeds takes place, the slow but long-continued germination of unstratified cultures is readily explained in any of those species not requiring stratification.

Explanation of the Table

All germination figures over 50 per cent are printed in bold-faced type. The numbers at the top of columns are explained as follows:

1. Habitat groups of species: A. Species of the higher interior (forested) mountains. B. Species of the lower interior (chaparral-covered) mountains. C. Species from the low coastal (mostly fog-belt) hills. D. Species from very close to the ocean.
2. A germination period of six weeks, instead of the usual two weeks.
3. Medium was river sand. A germination period of three weeks instead of the usual two weeks. The rate of seedling emergence appeared to be slower in sand than in half sand and half loam.
4. Stratification period three and a half months, instead of the usual three months.
5. Stratified at 2.5° C. for one and a half months, and then at 5° C. for one and a half months.

List of Seed Samples

Each seed collection used in the experiment was: (1) collected in the field by the writer; or (2) furnished by the California Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, through the courtesy of Mr. C. J. Kraebel; or (3) purchased from Lester Rowntree and Co., Carmel, California; or (4) purchased from Aggeler and Musser Seed Co., Los Angeles. In the seed list these sources have been abbreviated to: (1) Quick, (2) C.F.E.S., (3) Rowntree, and (4) A. & M. Seed Co.

The order of data in the list below is as follows: species; seed year; source of seed; approximate elevation of collection; collection notes. 1. *C. arboreus* Greene. 1931. Rowntree. 500 feet. Santa Cruz Island, Santa Barbara Channel Islands. 2. *C. austromontanus* Abrams. 1932. Rowntree. 3,000 feet. Cuyamaca Mt., San Diego County. The type collection was made in coniferous forests. 3. *C. cordulatus* Kell. 1931. Quick. 5,000 feet. South Fork of Stanislaus River, Tuolumne County. 4. *C. crassifolius* Torr. 1932. C.F.E.S. 2,800 feet. Barranca Burn, Devil Canyon, San Bernardino National Forest, Lot No. 739. 5. *C. cuneatus* (Hook.) Nutt. 1932. C.F.E.S. 2,500 feet. Kendall Drive, San Bernardino, California. Lot No. 737. 6. *C. cyaneus*

[3] Contr. Boyce Thompson Inst. 6: 69–89. 1934.

TABLE I

GERMINATION OF CEANOTHUS SEEDS. EFFECTS OF PLANT HABITAT, HOT WATER, AND STRATIFICATION ON PERCENTAGE GERMINATION.

Habitat group[1]	Seed collection No.	Ceanothus species	Usual number of seeds per culture	Seed year	Seeds not stratified (not stored moist at low temperature) after hot-water treatment. Germination period of 16 weeks in greenhouse. Hot-water treatments as given below.						Seeds stratified (stored in moist cultures) at 2½° C. for 3 months after hot-water treatment. Germination test of 2 weeks in greenhouse. Hot-water treatments as given below.					
					No hot water	Boiled one min.	Boiled 5 min.	70° C. to cool	80° C. to cool	90° C. to cool	No hot water[2]	Boiled one min.[3]	Boiled 5 min.	70° C. to cool[3]	80° C. to cool[4]	90° C. to cool[5]
A	2	*C. austromontanus*	40	1932	0	0	0	0	0	0	3	8	0	**64**	48	13
A	3	*C. cordulatus*	40	1931	3	15	0	10	5	0	5	**60**	**53**	**50**	**65**	13
A	11	*C. integerrimus*	25	1931	0	0	0	0	0	—	0	**68**	28	44	**85**	—
A	19	*C. velutinus*	40	1932	0	5	10	5	3	20	3	30	**63**	25	**68**	25
B	4	*C. crassifolius*	25	1932	16	40	28	48	13	24	12	**56**	**52**	**76**	**50**	48
B	5	*C. cuneatus*	25	1932	4	48	8	**60**	24	23	0	32	4	**92**	**56**	23
B	8	*C. divaricatus*	40	1933	3	36	15	33	35	43	0	48	20	**67**	45	8
B	13	*C. purpureus*	40	1932	3	30	13	**53**	20	8	0	35	0	28	35	8
B	15	*C. sorediatus*	40	1930	0	—	38	—	—	—	0	—	**100**	—	—	—
C	6	*C. cyaneus*	40	1933?	—	**60**	—	**65**	**53**	35	—	10	—	35	**60**	35
C	9	*C. foliosus*	40	1932	28	**65**	18	**77**	20	28	33	**56**	0	**92**	**50**	28
C	10	*C. incanus*	40	1931	3	33	5	15	—	25	3	46	0	**51**	**70**	43
C	12	*C. papillosus*	40	1933	0	0	18	0	3	5	3	23	3	39	**75**	**50**
C	14	*C. rigidus*	40	1930	13	**75**	3	**92**	48	15	8	29	0	33	15	8
C	16	*C. spinosus*	20	1933?	5	—	**100**	—	—	—	5	—	**65**	—	—	—
C	17	*C. spinosus*	40	1933	3	**88**	0	**100**	**84**	—	0	44	0	**88**	**96**	—
C	18	*C. thyrsiflorus*	40	1933	0	**68**	**50**	**73**	45	**55**	0	**63**	28	**83**	**55**	45
D	1	*C. arboreus*	33	1931	4	—	24	—	**61**	**90**	20	—	0	—	—	20
D	7	*C. dentatus*	40	1932	10	43	0	**60**	38	30	28	40	0	**83**	**60**	18
D	20	*C. verrucosus*	10	1932	20	—	0	—	—	—	5	—	0	—	—	—
A	Average of 4 species				1	5	3	4	2	7	3	42	36	46	**67**	13
B	Average of 5 species				5	39	20	49	23	25	2	43	35	**66**	47	22
C	Average of 7 species				8	**56**	28	**60**	42	27	8	39	14	**60**	**61**	35
D	Average of 3 species				11	—	8	—	**50**	**60**	18	—	0	—	—	19

Eastw. 1933. A. & M. Seed Co. No data on collection. The species is related to *C. thyrsiflorus* Esch. The original collection was made at Lakeside, San Diego Co., at an elevation of 1,500 feet. 7. *C. dentatus* T. & G. 1932. Rowntree. 20 feet. Coastal plain just north of Monterey, near town of Marina. 8. *C. divaricatus* Nutt. 1933. C.F.E.S. 2,500 feet. Trail to Panorama, Devil Canyon Forest Experiment Station, San Bernardino National Forest. 9. *C. foliosus* Parry. 1932. Rowntree. 1,500 feet. Seed produced on plant at Carmel, transplanted from near Mt. Tamalpais, Marin Co. 10. *C. incanus* T. & G. 1931. Rowntree. 500 feet. Bear Creek Road, Santa Cruz Mts., just east of (town of) Boulder Creek. 11. *C. integerrimus* H. & A. 1931. Quick. 4,800 feet. River flat with other species of "hard-chaparral," South Fork of Stanislaus River, Tuolumne County. 12. *C. papillosus* T. & G. 1933. Rowntree. 250 feet. About five miles south of Santa Cruz, on road to Watsonville. 13. *C. purpureus* Jepson. 1932. Rowntree. 2,000 feet. Napa Range, east of Napa. 14. *C. rigidus* Nutt. 1930. Rowntree. 500 feet. Carmel Highlands, four miles south of Carmel on Coast Road. 15. *C. sorediatus* H. & A. 1930. Rowntree. 1,000 feet. Napa Range, five miles northeast of Napa, on road to Monticello. 16. *C. spinosus* Nutt. Sample II. 1933? A. & M. Seed Co. Collection data not known. See next. 17. *C. spinosus* Nutt. Sample I. 1933. Quick. 250 feet. University of California Campus at Berkeley. Horticultural. 18. *C. thyrsiflorus* Esch. 1933. Quick. 750 feet. John Garber Park, Berkeley Hills. 19. *C. velutinus* Dougl. 1932. Rowntree. 6,000 feet. East side of Sonora Pass in Sierras. 20. *C. verrucosus* Nutt. 1932. Rowntree. 250 feet. Point Loma, San Diego County.

Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture, April, 1935.

A VEGETATION TYPE MAP OF CALIFORNIA

A. E. Wieslander

Those interested in the California flora will be glad to know that published units of a vegetation type map of California will soon be available for distribution. This map is being prepared as a part of a forest survey of California conducted by the United States Forest Service in cooperation with other federal and various state and county agencies. The survey embraces a total area of nearly seventy million acres and will cover the entire state exclusive of the deserts and the larger valleys devoted mainly to agriculture. When complete there will be a total of 220 map units. These units consist of the standard United States Geological Survey 15 and 30 minute topographic sheets upon which the vegetation types are shown in color and symbol legend. To date, field work has been completed on forty-eight units of which eight are now off the press and fourteen additional are in the process of publication.

The vegetation types are mapped in the field directly upon Geological Survey topographic quadrangles by direct observation and sketching from ridges, peaks, and other vantage points, supplemented by frequent sample-plot checks. The major types which are shown by color legend are further subdivided into pure and mixed stands in which species composition is indicated by symbols. A pure stand is defined as one in which a single species forms more than 80 per cent of the vegetation cover;